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# Biogenesis of Zinc oxide Nanoparticles using *Morinda pubescens* J.E. Smith Extracts and their Characterization

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**ABSTRACT**
Zinc oxide nanoparticles were synthesized from the aqueous extracts of mature leaves, stem, stem bark, dried bark of stem, roots, flower petals, immature and ripened fruits of *Morinda pubescens* J.E. Smith in present study. All parts of this plant are used in different Indian systems of medicine. The phytochemicals with antioxidant properties is accountable for the preparation of metal Zinc oxide nanoparticles. The Zinc oxide nanoparticles were synthesized using Zinc Nitrate hexahydrate ($Zn(NO_3)_2.6H_2O$) solution at room temperature. The synthesized nanomaterial was subjected to spectral analysis for characterization. The nanoparticle suspension gave maximum UV-Vis absorbance peak at 290 nm to 300 nm. The results indicate that almost same types of phytochemicals are present in all the parts of the plant which are responsible for the formation of Zinc oxide nanoparticle.

**Key words:** Green synthesis, Zinc oxide nanoparticles, *Morinda pubescens*, aqueous extracts, characterization.

## INTRODUCTION

The manipulation of matter with at least one dimension sized from 1 to 100 nm is considered in nanotechnology. Zinc oxide (ZnO) is non toxic and it can be used as photocatalytic degradation materials of environmental pollutants. It has extensive applications in water purification [1] to remove arsenic, sulphur etc. from the polluted water [2].

Zinc oxide nanoparticles are used in the preparation of substances possessing medically as well as cosmetically useful properties. These are used along with iron oxide to prepare calamine lotion, and with eugenol for dental applications [3,4]. These are also used in rectal suppositories to provide relief from the discomfort and irritation caused by hemorrhoids. Zinc oxide is used in sunscreen lotions, since it is capable of absorbing ultraviolet light, and thus protects the skin from sun damage [5]. These nanoparticles have found fabulous application in biomolecular detection, diagnostics, antimicrobial textile industries [6] and micro-electronics [7].

Biological synthesis of ZnO nanoparticles have been reported in several plant species, biological approach using milky latex of *Calotropis procera* has been used as a reducing material as well as surface stabilizing agent for the synthesis of ZnO nanomaterials [8]. Highly stable ZnO nanoparticles have synthesized using *Aloe vera* extract [9], aqueous leaf extracts of *Calotropis gigantia* [10] *Corriandrum sativum* leaf extract and *Acalypha indica* leaf extract [11,12].

Shailaja et al, [13] synthesized ZnO nanoparticles and tested their antibacterial activity against Gram positive and Gram negative bacteria. Due to its antibacterial properties, zinc oxide is applied on the skin, in the form of powders, antiseptic creams, surgical tapes and shampoos.

We have developed a facile and eco-friendly method for the synthesis of Zinc oxide nanoparticles using aqueous plant extracts of *Morinda pubescens* J.E. Smith (family Rubiaceae) with Zinc Nitrate hexahydrate as precursor. The different parts of the plant are used in different indigenous systems of medicine such as Ayurveda, Siddha, Unani, Tibbi and Amchi [14,15]. The phytochemicals with antioxidant properties is accountable for the preparation of metal and metal oxide nanoparticles.

To the best of our knowledge, biological approach using aqueous extract of leaves, stem, stem bark, dried bark of stem, roots, flower petals, immature and mature fruits of *Morinda pubescens* have been used for the first time as a reducing material for the synthesis of ZnO nanoparticles.

## MATERIALS AND METHODS

*Morinda pubescens* is also known as Nuna in South India. The plant material was collected from the coastal area of Pondicherry, India. The *Morinda pubescens* trees were identified with the help of 'The Flora of Presidency of Madras' [16]. Fresh, green and mature leaves, stem, stem bark, dried bark of stem, roots, flower petals, immature and mature fruits were harvested during the months of November, 2013 to January, 2014. The materials were thoroughly washed with distilled water and finely cut in small pieces (Fig.1-8A and B.)

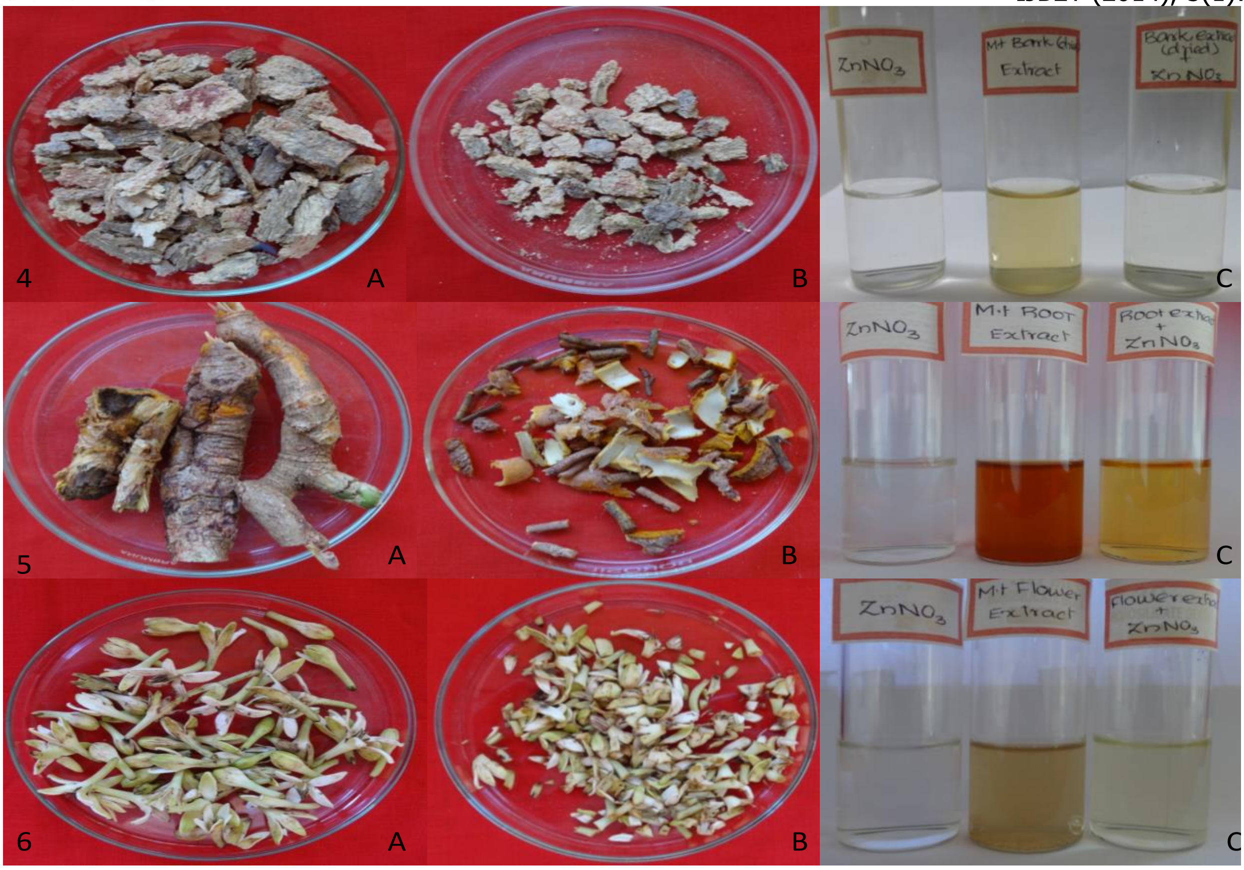
The plant extracts (broth solutions) were prepared by using 5gm of washed and cut leaves, stem, stem bark, dried bark of stem, roots, flower petals, immature and mature fruits pulp, in a 250ml Erlenmeyer flask with 50 ml of sterile distilled water and then boiling the mixture for 5min in water bath. The herbal aqueous extract was collected in separate conical flasks by standard filtration method and stored at 4ºC in a refrigerator.

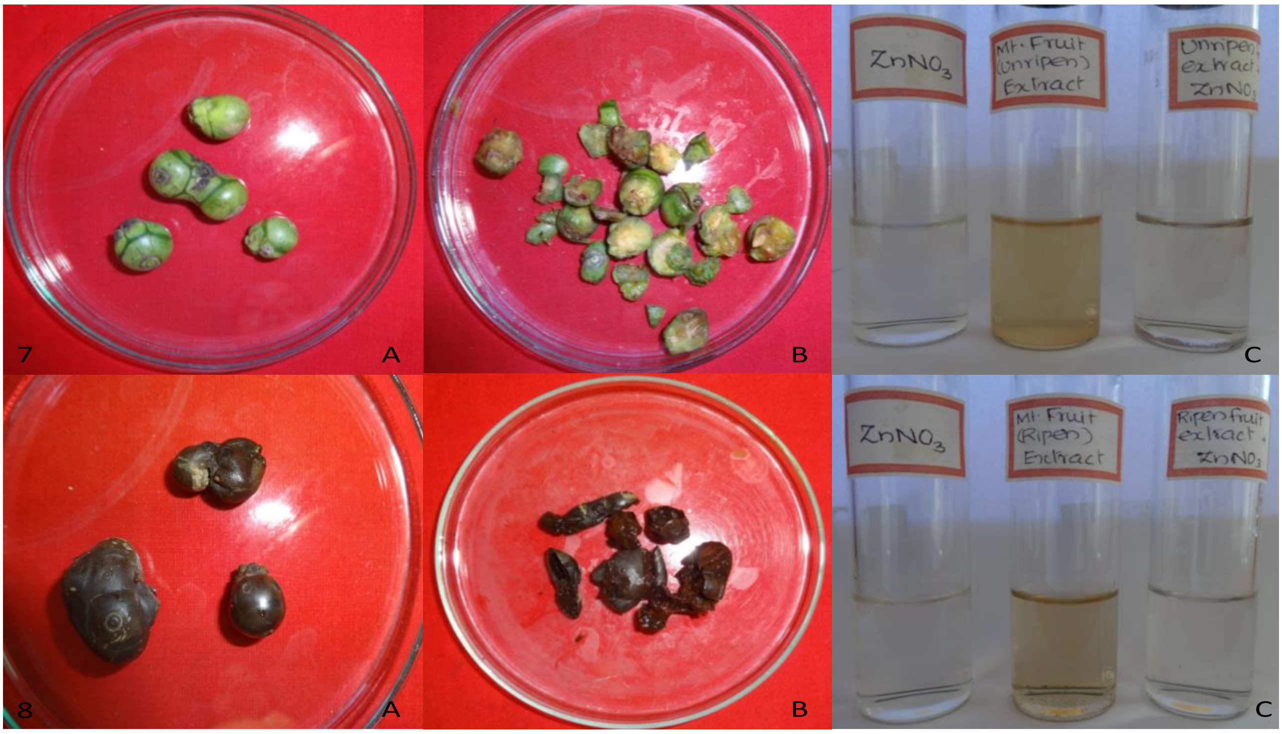
1mM Zinc nitrate solution was prepared using Zinc Nitrate hexahydrate ($Zn(NO_3)_2.6H_2O$) (Merck, Mumbai) and stored in brown bottle at $4^oC$ for further use. For the synthesis of Zinc oxide nanoparticles, two boiling tubes were taken, one containing 10ml of 1mM Zinc nitrate solution as control and the second one containing 9ml of 1mM Zinc nitrate solution and 1ml of plant extracts as test solution (Fig. 1-8C)

The Zinc nanoparticles which were synthesized from the plant extracts were centrifuged at 5000 rpm for 15 min in order to obtain the pellet which is used for further study. Supernatant is discarded and the pellet is dissolved in deionized water. The zinc nanoparticles were confirmed and characterized by UV-Visible spectrophotometer (Systronics Double Beam Spectrophotometer, (Model 2202, Systronics Ltd.). The UV-Vis absorption spectra of the zinc colloids were recorded by using wave length scan between 200nm and 700nm.

## RESULTS AND DISCUSSION

The green synthesis of zinc oxide nanoparticles using leaf, stem, stem bark, dried bark of stem, root, flower petals, immature and mature fruit pulp extracts of *Morinda pubescens* was carried out in present investigation. The color was not changed in the cell free leaf extract when challenged with 1mM Zinc nitrate solution without heating the mixture (Fig. 1-8C) even after two hours. Color was slightly changes (from colorless to pale yellow) when the mixture solution was heated in the oven at $60^o$ C for ten minutes. In case of biogenesis of silver nanoparticles color of the mixture solution was changed even within five minutes in our previous study in with *Turnera ulmifolia* [17]. Crystalline Zinc oxide is thermochromic, which changes from white to yellow colour when heated and reverting to white colour on cooling.




Figs. 1to 8: Different parts of *M. pubescens* used for biosynthesis of ZnO nanoparticles.1(A to C) Leaves and the reaction mixtures, 2(A to C) Stem segments and the reaction mixtures, 3(A to C) Bark and the reaction mixtures, 4(A to C) Dried bark and the reaction mixtures, 5(A to C) Roots and the reaction mixtures, 6(A to C) Flower petals and the reaction mixtures, 7(A to C) Immature fruits and the reaction mixtures, 8(A to C) Ripened fruits and the reaction mixtures.

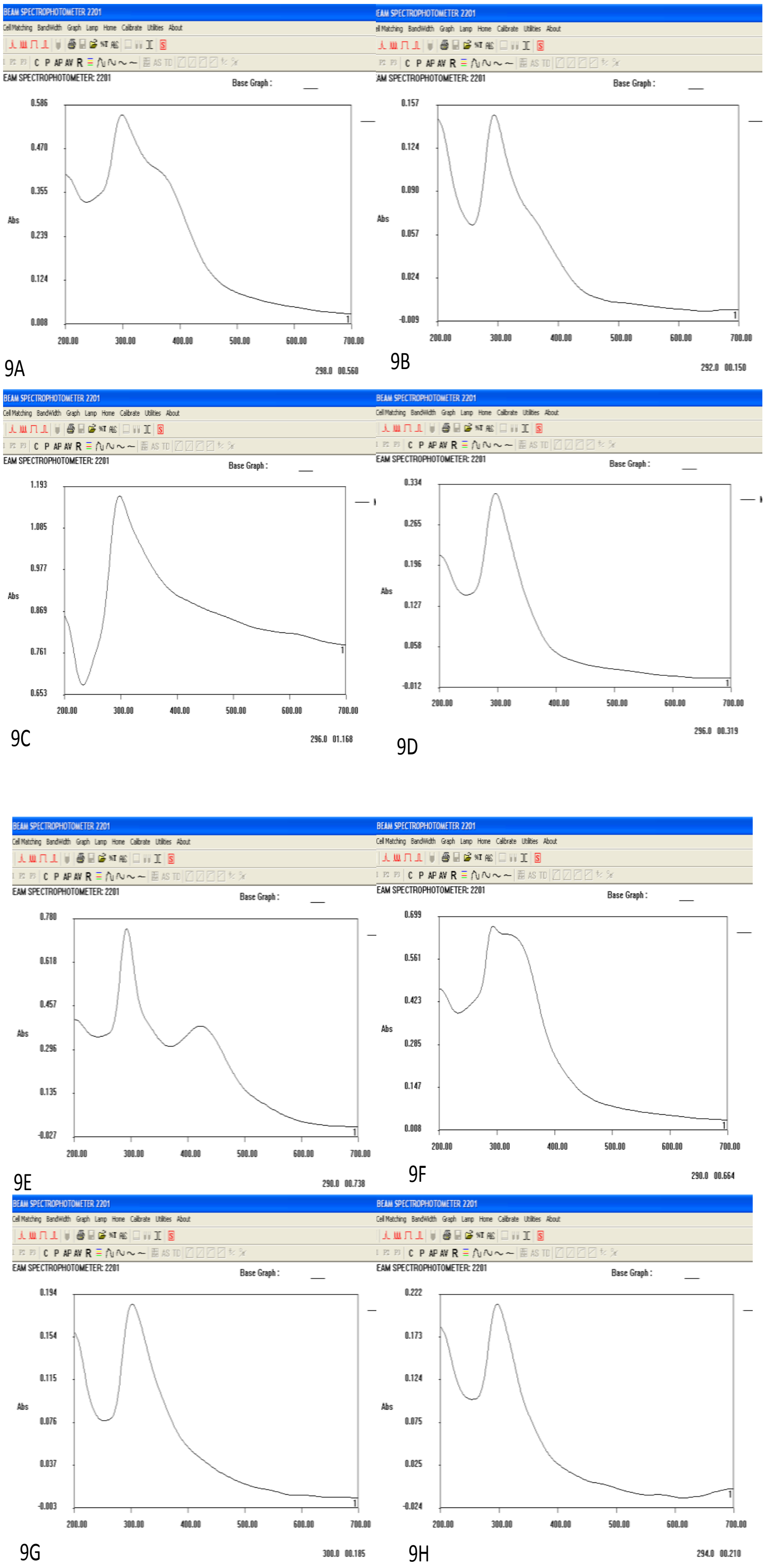



Fig. 9: UV-Vis spectral analysis of Zinc oxide nanoparticles. (9A) Absorbance peak with leaf extract, (9B) Absorbance peak with stem extract, (9C) Absorbance peak with bark extract, (9D) Absorbance peak with dried bark extract, (9E) Absorbance peak with root extract, (9F) Absorbance peak with flower petals extract, (9A) Absorbance peak with immature fruit pulp extract, (9A) Absorbance peak with ripened fruit pulp extract.

The biosynthesis mechanism for ZnO nanoparticle involves an enzyme-mediated process. Extracts from plants may act as reducing and capping agents in nanoparticles synthesis.

The proteins present in extracellular secrets, mentioned as capping proteins, further encapsulates the ZnO nanoparticle and increases its stability. *M. pubescens* reported the presence of glycoside (morindone), tinctomorone, damnacanthal and nordamnacanthal, ursolic acid, anthraquinones, soranjidol, ibericin, ru-biadin, D-mannitol, anthragallol-2, and 3-di methyl ether [18,19,20,21,22].

The presences of these phytochemicals in the aqueous extracts of various plant parts are the possible surface dynamic molecules which stabilized the Zinc oxide nanoparticles.

The optical properties of the synthesized zinc oxide nanoparticles were revealed by UV-Vis spectrophotometer at room temperature, as shown in the Fig. 9. It can be seen from the Fig. 9A to 9H that there was intensive absorption in the ultraviolet band of about 290-300 nm. The Zinc oxide nanoparticles synthesized using aqueous leaf extract showed absorption peak at 298 nm, stem extract 292 nm, bark extract 296 nm, dried bark extract 296 nm, root extract 290 nm, flower extract 290 nm, immature fruit extract 300 nm and ripened fruit extract at 294 nm.

These results clearly indicate that about same type of phytochemicals are present in all the parts of the plants which were responsible for the reduction of metallic Zinc to nanoparticle size. In previous study for the biosynthesis of silver nanoparticles using aqueous extracts of different parts of *Couroupita guianensis*, it was observed that fruit pulp extract showed a very clear, stable and sharp absorption peak as compared to other extracts like, leaf, stem, flower etc. [23]. Jain et al, [24] also supports our results; they described the biological approach for Zinc oxide nanoparticles synthesis.

The absorption wavelength at about 300 nm of ZnO suggested the excitonic character at room temperature. Vanheusden et al, [25] described that the UV emission is attributed to the radiative recombination between the electrons in the conduction band and the holes in the valence band. Whereas Mahamuni et al, [26] have described that the visible luminescence is due to defects related to deep level emission.

The biologically synthesized Zinc oxide nanoparticles in present report can be directly used in agricultural, biomedical, engineering and allied sectors. The foliar spray of these particles showed better growth of plants [27]. This approach can opens new door for fertilizer industries to produce nanofertilizer for plant nutrition as growth supplement.

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